6.0 LANDSCAPING AND LIGHTING

Bristol Airport

6.1 Landscape Design

An integrated/embedded landscape, visual and ecology mitigation masterplan forms part of the planning application alongside measures to mitigate ecological impacts. Measures that have been designed for landscape and visual purposes include (inter alia):

- New tree planting to be undertaken to replace that lost and to reinforce existing high levels of tree cover along the relevant lengths of the boundary of Bristol Airport. The design of new planting has been located to deliver screening and softening of large-scale built form, with particular regard to MSCP Phase 3, and is proposed close to the Downside Road entrance to the airport and alongside the boundary with Cook's Farm where it will reinforce the existing tall hedgerow providing increased longer-term screening for some visual receptors in Downside and Cook's Bridle Path;
- Parkland planting alongside the northern boundary close to the residential properties on the southern side of Downside Road. Although the primary purpose of this planting is habitat enhancement for horseshoe bats, it will establish to provide longer-term enhancement of the existing screening of the closest parts of the northern area surface car park and the proposed gyratory road;
- New planting on the northern side of the proposed extended terminal building and canopy in the style of the present ornamental and street tree planting. This planting will break up the mass of the extended terminal building in occasional close distance views that are available to visual receptors from elevated locations to the north on the Oatfield Ridge;
- Replacement hedgerow and tree planting alongside sections of the proposed gyratory road; and
- A perimeter bund around the western, southern and eastern boundary of the Silver Zone car park extension (Phase 2) to be designed and planted to replicate the design of the bund sited around the existing Silver Zone car park extension (Phase 1).

Where applicable, for each development component, detailed landscaping will be submitted as a reserved matter.

6.2 Lighting Strategy

In accordance with the ILP Professional Lighting Guide 04: Guidance on Undertaking Environmental Lighting Impact Assessments, the site has been assessed through a desk top and on-site survey. The sensitive receptors near to the site have been identified and indicative lighting modelling has been produced to determine the impact on these receptors.

Please refer to the Lighting Impact Assessment produced by Hydrock for more information.

6.2.1 Legislation, Policy and Guidance

The following legislation, policies and standards have been identified as relevant for the scheme:

- Environmental Protection Act 1990;
- Clean Neighbourhood and Environment Act 2005;
- National Planning Policy Framework 2018;
- North Somerset Council Core Strategy – Policy CS3
- North Somerset Council Core Strategy – Policy CS23
- ICAO Annex 14 – Volume 1: Aerodrome Design and Operations (July 2016);
- Airport Planning Manual Part 2: Land Use and Environmental Control; and
- The Civil Aviation Authority: CAP 168

6.2.2 Impact on Sensitive Receptors

Following the lighting survey, the sensitive receptors of the site have been identified and indicative lighting modelling has been produced to assess the light impact on these areas:

- Residences along Downside Road – negligible effect;
- Residences along the A38 - negligible effect;
- The Mendip Hills Area of Outstanding Natural Beauty (AONB) - minor and acceptable; and
- Dark agricultural to the South and East of the site - minor and acceptable.

6.2.3 External Lighting Strategy

An indicative Lighting Impact Assessment forms part of the planning application. The strategy has been designed to be compliant to Dark Sky requirements, Lighting Environmental Zone E2 and the relevant legislation, policy and guidance stated in 6.2.1.

The following principles have been adopted when designing the scheme:

- The use of directional, LED lamps to both save energy and ensure that light is only directed to the required areas;
- Proposed luminaires have a 0° tilt and are designed to have a ULR of <5%;
- Within existing car park areas to the south of the site, it has been recommended that these luminaires are fitted with Passive Infrared Sensors (PIRs). This will serve to save energy, reduce carbon consumption and ensure that illuminance is only provided when necessary, reducing the perceived effect of the areas; and
- A warm white Correlated Colour Temperature (CCT) of 3,000 K has been used to create a warm, welcoming environment and reduce the emission of white and blue wavelengths of the light spectrum. In airside operational areas, a CCT of 4000°K or above may be required.

7.0 ENVIRONMENTAL SERVICES AND SUSTAINABILITY

Bristol Airport


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7.1 Introduction

The planning application provides a crucial opportunity to not only reduce carbon emissions but also introduce innovative ways to provide sustainable elements such as green infrastructure and renewable technology. A development for an existing international gateway, which is a key asset to the West of England, nationally and regionally, should shine and excel in terms of sustainable airport development; this is a key design principle for this development.

Noting the significance and importance of this planning application, sustainability has underpinned the design of the Proposed Development. From the early stages of design through to submission the design team have been working to ensure that sustainability is fully integrated into the design, embedding mitigation where it is appropriate to do so.

Furthermore, the design team have focused on the requirements of BREAAM, the Building Research Establishments Environmental Assessment Method, in order to set out a framework to achieve a 'Very Good' rating. However, where possible the design team has pushed for 'Excellent' delivery levels.

Having this approach has enabled the design team to actively work towards the sustainability planning standards bestowed by North Somerset Council's Core Strategy (2017) where under the section 'Living within environmental limits – CS2: Delivering sustainable design and construction':

1. *"require designs that are energy efficient and designed to reduce their energy demands;*
2. *require the use of on-site renewable energy sources or by linking with/contributing to available local off-site renewable energy sources to meet a minimum of 10% of predicted energy use for residential development proposals involving one to nine dwellings, and 15% for 10 or more dwellings; and 10% for non-residential developments over 500m² and 15% for 1000m² and above;*
3. *require as a minimum Code for Sustainable Homes Level 3 for all new dwellings from October 2010, Level 4 from 2013, rising to Level 6 by 2016. Higher standards will be encouraged ahead of this trajectory where scheme viability specifically supports this. BREEAM 'Very Good' will be required on all non-residential developments over 500m² and 'Excellent' over 1000m²;*
4. *require all developments of 10 or more new homes to incorporate 50% constructed to the Lifetime Homes standard up to 2013 and 100% from 2013 onwards.*
5. *require the application of best practice in Sustainable Drainage Systems to reduce the impact of additional surface water run-off from new development. Such environmental infrastructure should be integrated into the design of the scheme and into landscaping features and be easily maintained."*[9]

In conjunction with this Planning Application, policy points 2, 3 and 5 are considered. The Sustainable Drainage System elements are covered in section 7.11 of this document.

The following sections provide a brief summary of the measures as detailed under BREEAM which have been included as part of this planning application to ensure sustainable development is embedded during the construction and ultimately operation of 12 mppa airport.

The design team has also considered the impacts of climate change over the operational period of the Proposed Development. Considering the resilience of the built infrastructure to the effects of climate change, and applying adaptation to the design where necessary, ensures that the Proposed Development maintains its functionality over time. The implications of climate change on embedded environmental mitigations have also been considered in the **Environmental Statement Chapter 11: Biodiversity, Chapter 12: Surface Water and Flood Risk and Chapter 13: Groundwater.**

7.2 Building Services and Sustainability

The construction of buildings, associated services and final operational use can have a significant impact on energy use and therefore increase overall energy demand and consumption if not managed within the design from the outset. The approach to building services design is through a means to eliminate and reduce energy use and associated carbon emissions.

To do this the design team will seek to undertake the following:

- Prior to completion of the Concept Design, relevant members of the project team hold a preliminary design workshop focusing on operational energy performance;
- Undertake additional energy modelling during the design and post-construction stage to generate predicted operational energy consumption figures;
- Report predicted energy consumption targets by end use, design assumptions and input data;
- Carry out a risk assessment to highlight any significant design, technical, and process risks that should be monitored and managed throughout the construction and commissioning process;
- Ensure that sub-metering is installed and that this is reported on a floor by floor basis and that the building users can access this to review energy consumption;
- Ensure external lighting conforms with:
    - Average initial luminous efficacy of not less than 70 luminaire lumens per circuit Watt
    - Automatic control to prevent operation during daylight hours
    - Presence detection in areas of intermittent pedestrian traffic. Where there is any external lighting need to ensure this meets the luminaire lumens per circuit Watt requirements;
- Ensure Lifts, Escalators and Walkways have the facility to reduce energy consumption when not in use; and
- Carbon reduction will be holistic and will encompass cooling, ventilation, lighting and heating.

Any such measures will be included where reasonably practicable without inhibiting excessive costs.

9 http://www.n-somerset.gov.uk/wp-content/uploads/2015/11/Core-Strategy-adopted-version.pdf

7.3 Bristol Airport Sustainability Targets

To achieve credible and sustainable, energy/emissions reduction design BAL has established an ambitious set of sustainability targets for the development as follows:

- To achieve a 15% energy consumption through the installation and use of on-site renewables;
- To reduce operational water consumption by 40% with improvement over the baseline building water consumption (common areas);
- To avoid waste to landfill through construction via the implementation of a site CEMP. An outline CEMP is contained within the Environment Statement for reference purposes;
- In line with targeted BREEAM credits, the final materials choice will be informed by The Green Guide to Materials Specification to encourage the use of construction materials with a low environmental impact (including embodied carbon) over the full life cycle of the development;
- In accordance with the standards set by BREEAM, best construction practices and methods will be used in executing the construction works, to avoid or reduce the potential for air, noise and vibration, and water pollution. It is intended that these practices and methods should be a contractual requirement; and
- Achieving a best practice score in the Considerate Constructors Scheme (CCS), which ensures the considered management of construction sites.

Energy reductions will be achieved through the following savings measures as appropriate:

Passive Measures:

- Minimise heat loss through efficient thermal envelope of the building;
- Use of natural daylight where possible in the building;
- Introduction of solar shading or treated glazing where appropriate to reduce heat gain causing additional cooling;

Active Measures:

- Low energy building systems such as low energy Heating, Ventilation and Air Conditioning (HVAC) systems, occupancy sensors and an integrated Building Management System (BMS) with the existing terminal infrastructure;
- High efficiency plant and building equipment;
- High efficacy lighting such as LED as standard; and
- Sub Metering for electricity, gas and water where appropriate linking with the integrated Building Management System.

These measures will be further developed at detailed design stages.

The proposed renewables as part of the in-built design include:

- The provision of solar PV on terminal extensions;
- Air source heat pumps;
- The installation of small wind turbines on the MSCP; and
- The inclusion of Combined Heat and Power (CHP).

The energy saving proposals will be capable of reducing on going energy consumption of the completed development whilst in addition to delivering 15% reduction in energy use from renewables.

7.4 BREEAM

Building Research Establishment's Environmental Assessment Method (BREEAM) is the leading environmental assessment method for UK non-residential buildings. It sets the standard for best practice sustainable design and encourages and certifies that best environmental practice is incorporated within building design and construction.

BREEAM is a nationally recognised standard for the design and construction of new non-residential developments. The BREEAM assessment process involves the evaluation of a building's performance against the scheme and its criteria using an independent third-party licensed BREEAM assessor. A BREEAM certificate provides formal verification that the assessor has completed an assessment of the building in accordance with the requirements of the scheme and its quality standards and procedures have been met. A BREEAM certificate verifies that a building's BREEAM rating, at the time of certification, accurately reflected its performance against the BREEAM standards.

BREEAM UK New Construction 2018 (published in March 2018) relates to standard building typologies and is applicable to new non-domestic development located in the United Kingdom. The BREEAM standard assesses and awards credits based on the environmental performance of non-residential developments within a framework of nine categories, these being:

- Management;
- Health and Wellbeing;
- Energy;
- Transport;
- Water;
- Materials;
- Waste;
- Land use and Ecology; and
- Pollution.

BREEAM also awards additional credits in recognition of sustainability related benefits or performances that go beyond best practice, termed *innovation credits*. An additional 1% can be added to a building's overall score for each 'innovation credit' achieved up to a maximum of 10 credits for any one building, with the potential to score 110%. Innovation credits can be awarded regardless of the building's final BREEAM rating.

BREEAM should be implemented at different stages of the design (pre-assessment), construction (typically design stage assessment) and use of a building (final certificate). BREEAM assessment of a new build, refurbishment or fit-out is split into three main stages:

- BREEAM pre-assessment (which encompasses this report) at RIBA stage 1/2, or at the earliest convenience, which will form the basis for the inclusion of BREEAM principles and awareness in the whole design process – leading to a pre-assessment report;
- Assessment of the design and commitments against the BREEAM criteria– this leads to an interim certificate; and
- Review of the building during and post construction to ensure the design and commitments have been fully implemented in the building – this leads to a final certificate.

A full assessment is required to deliver a final certificate.

The categories within BREEAM are weighted according to their level of importance. Each category is allocated a different number of credits and therefore individual credits carry specific weightings, as a percentage of the total points score.

It is important to note that a bespoke assessment for airports is required and therefore these section weightings are liable to change. The BRE, the technical authors of the BREEAM standard, alter the section weightings dependent on the building type. This is anticipated to be relatively minor in the instance of the 12 mppa application.

As part of the planning application the design team have undertaken a BREEAM pre-assessment, this is submitted as part of the application. This pre-assessment outlines the credits that are potentially achievable and those which the terminal development should target. The pre-assessment demonstrates that the terminal extensions can realistically achieve a BREEAM 'Very Good' rating; reflecting this, and taking account of the unique nature of airport-related development (including, inter alia, the specific operational and security requirements of terminals), BAL proposes that the terminal extensions are designed to achieve a BREEAM 'Very Good' rating, but striving for 'Excellent' delivery levels where possible. The BREEAM process will only relate to the terminal building extensions.

7.5 Renewable Low Carbon Technology Requirements

The development is expected to meet the 15% renewable energy target as prescribed by North Somerset Council's Core Strategy Policy CS2: Living Within Environmental Limits.

The breakdown of the overall energy consumption for direct and indirect emissions (more commonly known as Scope 1 and 2 emissions as part of the Greenhouse Gas Protocol) for the development is in Figure 7.5 below:

The total energy requirement for the 12 mppa development is 3,911,580 kWh per annum (3.9 MWh) the targeted 15% will be 1.8 MWh per annum from on-site renewables.

7.6 Renewable Energy Options

To achieve the stated 1.8 MWh per annum as above a number of renewable energy options have been considered. The following is a breakdown of these and their suitability in terms of the development:

Building or Zone Description	Floor Area	Building Area Classification (kWh/m^2/yr)	Total Energy Consumption per year (kWh)
West Terminal Extension Phase 2A	10,385	141.25	1,466,881
South Terminal Extension	3,531	141.25	498,754
New Arrivals VCC (Bussing)	195	40	7,800
New Arrivals VCC (Bussing)	214	40	8,560
New Arrivals VCC (Bussing)	64	40	2,560
Walkway to East Pier with VCC to 1 no. PBZ	2,948	35	103,180
East Pier with VCCs and 5 no. PBZs	3,815	35	133,525
East Walkway Coaching Gates (4 no.)	2,472	35	86,520
MSCP Phase 3	55,920	15	838,800
Silver Zone Car park Permanent Fixed Lighting	51,000	15	765,000

Fig. 7.5 Overall Energy Consumption for Direct and Indirect Emissions

Renewable Technology	Option for taking further (Yes/No) and explanation
Biomass	**No** – due to the nature of the development Biomass is not deemed to be suitable due to size nor cost effective. The resulting impact of biomass is restriction on use with particular ‘fuels’ required meaning adequate storage for wood pellets and in the generation of additional transportation movements to site for deliveries which isn’t desirable.
Wind turbines (Large Scale)	**No** – Large scale wind turbines are not suitable for this type of development as, due to their size and height, the isn’t an adequate location on site which will not interfere with aerodrome navigational aids or be at a safe height for safeguarding purposes.
Wind turbines (Medium to Small Scale)	**Yes** – the airport already has plans for small (20kWh) turbines to be installed as part of the existing multistory carpark therefore his would be acceptable.
Solar Thermal	**Yes** – this technology has limited reach as it main use is for the generation of hot water and, for it to have a meaningful impact, such installation must be located near the point of use to avoid transmission losses.
Photovoltaic Cells (Solar PV)	**Yes** – this technology has been successfully implemented at Bristol Airport with walkways and terminal extensions already having solar PV provision. This will be the key renewable to reach the airports 15% provision for renewable generation.
Other	**Yes** – the airport will seek to employ other energy reduction measures such as LED lighting, combined heat and power (CHP), absorption chillers and air source heat pumps.

Fig. 7.6 Renewable Technology Options

7.7 Potable Water

Potable water consumption will inevitably increase with increasing passenger numbers, with the use of facilities such as toilets and wash rooms being in higher demand. Therefore, the objective is to limit this increase as far as possible using sustainable measures which are outlined below.

There are two key measurable targets of this approach:

1. The peak flow rate of the airport currently is 25 m^3/h, the measurement of success is for this to remain whilst consumption is limited through measures; and
2. To reduce potable water consumption by 40% (common areas).

To achieve this objective the following sustainable measures have been considered:

Water Saving Measures:

- Waterless urinals, where mechanically applicable;
- PIR (passive infra-red) flushing of toilets and urinals where applicable;
- Low flow taps;
- Timed taps either via pressure or sensor; and
- Reduced toilet basin sizes limiting water per use.

Alternative Supplies:

- Rain water capture, storage and use; and
- Potential use of underlying aquifer.

Reuse of natural resources:

- Black water capture, storage and use; and
- Grey water capture, storage and use.

The next stage is to cost, reappraise and validate each of these elements during the detailed design stage if the application is approved. This will include, through the continued work and engagement of the design team, to record the validation process of each element noting the objective and with a view to install such measures coupled with clear monitoring of performance post final install and commission.

7.8 Benchmarks and Targets

North Somerset Council's Core Strategy (2017) where under the section 'Living within environmental limits – CS1: Addressing climate change and carbon reduction' includes the need to[10]:

'developments should demonstrate water efficiency measures to reduce demand on water resources, including through the use of efficient appliances and exploration of the potential for rainwater recycling'.

The largest potential users of water at Bristol Airport are the terminal, hotel and catering facilities, with offices and industrial units using considerably less (discounting any industrial processes). As indicated in the previous 10 mppa application, terminal buildings typically use on average 20 l/passenger/visit. Potable water used is discharged to foul. Therefore, by using waste water recycling and rainwater collection systems there is potential for reducing water consumption within the buildings on the site, this is an area of consideration as per section 7.9.

10 North Somerset Council Core Strategy (2017), p22. http://www.n-somerset.gov.uk/wp-content/uploads/2015/11/Core-Strategy-adopted-version.pdf

7.9 Mains Water Consumption Targets

The mains water consumption target for the development is on based on previous performance and taking into consideration the amount of change, due to the scope of the development by making best use of the existing site, will bring.

As set out in Figure 7.9.1 below the average litre per passenger has increased since 2012 (0.0997) to 2017 (0.0128) by approx. 31%:

	Month	2012	2013	2014	2015	2016	2017
POTABLE WATER USE AVERAGE BY PAX (litres/pp)	January	12.43	12.75	12.15	11.46	14.16	15.84
	February	12.16	13.76	11.29	10.82	12.92	14.60
	March	12.18	19.19	10.62	9.82	12.62	14.59
	April	9.68	10.52	9.13	9.56	11.97	12.61
	May	10.45	7.92	9.09	8.11	10.71	12.37
	June	8.65	9.16	9.41	9.73	10.73	7.95
	July	8.54	8.01	7.90	10.18	10.38	11.94
	August	7.53	7.71	8.03	9.57	10.43	11.20
	September	8.21	8.44	8.65	10.84	11.03	11.71
	October	9.86	8.89	8.88	10.57	12.08	15.97
	November	10.51	11.66	10.78	12.48	15.68	14.58
	December	10.92	12.97	10.77	13.08	14.30	14.86
	Annual	**9.73**	**10.27**	**9.40**	**10.31**	**11.90**	**12.80**

Fig. 7.9.1 Average Litre per Passenger

	Month	2012	2013	2014	2015	2016	2017
TOTAL PASSENGERS BY MONTH	January	315,448	307,109	336,311	356,014	404,120	464,784
	February	356,642	350,562	362,881	376,367	432,495	482,447
	March	406,405	420,512	420,137	448,156	504,517	562,595
	April	485,726	478,874	499,265	536,065	592,640	665,528
	May	538,317	579,149	605,764	653,758	694,654	765,614
	June	604,359	621,148	642,666	702,360	761,036	841,953
	July	650,510	667,560	687,245	737,044	820,277	865,008
	August	672,787	698,680	721,788	769,984	845,111	894,028
	September	615,481	634,845	648,867	702,008	772,785	830,955
	October	546,941	566,264	582,077	634,500	706,799	761,828
	November	344,238	358,199	368,876	408,108	464,897	483,873
	December	338,050	346,304	367,200	407,770	499,382	509,834
	Total	**5,874,904**	**6,029,206**	**6,243,077**	**6,732,134**	**7,498,713**	**8,128,447**

Fig. 7.9.2 Total Passengers by Month

In isolation this level of increase in water consumption rising from approx. 10 litres per passenger in 2012 compared to approx. 13 litres per passenger in 2017 is high. However, this is a lower rate than passenger growth, as illustrated in Figure 7.9.2 .

The increase in passsengers over the same period has been almost 40%, ten percent greater than the litre per passenger metric. Therefore, Bristol Airport will look to reduce operational water consumption by 40% with improvement over the baselinebuilding water consumption (common areas).

7.10 Water Conservation

As part of the development of the design for this planned development, the following areas will be considered by the design team:

- Increase the number of water meters on the estate;
- Meters can be used to derive typical usage patterns, these can then be BMS monitored to identify unusual consumption;
- Identify and eliminate undue consumption.
- Involve staff and passengers in water efficiency initiatives;
- Publish consumption figures to raise user awareness;
- Continue to identify and eliminate leakage from the systems;
- Reduce water consumption, through water efficient equipment: low volume dual flush toilets, urinals with proximity sensors, waterless urinals, taps with flow restrictors where applicable;
- Assess potential use of greywater or rainwater for toilet flushing;
- Investigate the potential use of the aquifer as part of the water strategy; and
- Assess opportunities for rainwater harvesting.

All these elements will be considered to for integration into the detailed design stage.

7.11 Architectural Sustainability

Due to the importance of the environment and the subsequent need for sustainability, BAL are committed to ISO 14001. The overall objective of ISO 14001 and the associated management system is to establish a commitment to continual improvement of the environmental performance of individual designs and material specifications, measured by simple statistical analysis, to reduce associated environmental impacts. An integral part of the system aims to influence and encourage client/sub-contractors to also adopt sustainable development principles.

The preceding sections dealt specifically with energy and water consumption from a building services viewpoint. This section aims to address the building from a wider sustainability perspective, including material selection, from construction through to the operation of the completed building.

The main methods by which this will be achieved are:

- Introducing the sustainable aspects of the construction process at an early stage of the design and collaborating as a team to achieve the sustainability goals;
- Recycling construction waste using off site sorting including a dedicated space for recyclable materials on site;
- Providing a well insulated, air tight building by aiming to surpass the minimum standards required by the Building Regulations;
- Selection of structural materials. For example, the choice of steel as a structural element for the terminal extensions and walkways has many advantages:
    - It is 100% recyclable; it uses the minimum volume of materials.
    - It involves a clean, dust-free construction process that is vitally important for health and safety reasons when working in close proximity to aircraft.
    - There is minimal site wastage.
    - Good end-of-life options include dismantling of building and re-use of steel frame particularly if bolted joints are specified rather than welded joints.
    - Off-site fabrication in a controlled environment means better quality.
    - It is adaptable and flexible to suit the changing lifetime requirements of an airport;
- Using locally sourced materials where possible;
- Responsibly sourcing materials used in structural and non-structural elements;
- Using the BRE Green Guide to Specification to ensure that materials have an 'A' rating. For example, a large proportion of the building is clad in aluminium insulated panels which achieves an 'A' rating. General aim to target materials of low embodied energy to be negotiated at early stage of the detailed design;
- Careful selection of the curtain walling system. The main emphasis in the specification of the glazing will be to choose windows which will reduce operational energy usage in terms of heat loss and solar gain given the hours of operation at the airport. The amount of glazing in the terminal is a balance between minimising the embodied energy in producing the materials and maximising the positive benefits of natural daylight within the building, visual connections with the apron and countryside and the aesthetically relating to the existing architecture;
- Using SUDS (Sustainable Urban Drainage) such as permeable paving on the surface car parks. This has many advantages for the local environment including:
    - Reducing pollution from surface run-off pollutants such as oil and fuel
    - Reducing the risk of flooding
    - Infiltrating water back into the ground locally;
- Maximise the benefits of natural environmental systems by siting and design;
- Establish an overall site strategy that promotes/sustains biodiversity, where applicable in an airport environment;
- Aim to reduce the overall energy consumption of buildings (both in construction and life cycle in use within the available budget) and minimise carbon dioxide emissions;
- Understanding that life cycle and whole life costing must be a principal part of design and maintenance considerations;
- Aim to re-use and recycle where applicable with disposal being avoided;
- Aspire to utilise renewable materials and renewable energy resources wherever appropriate; and
- Consider the export of waste materials, in particular, excavated material, and how this can be minimised and methods to achieve this at both design and construction Phases.

A sustainable building must also take into account environmental, social and economic issues. The expansion of the airport will create more jobs for local people and provide better transport links for business travellers thereby supporting the growth of the local economy.

7.12 Climate Change Resilience

Climate change projections from UKCP09[11] for the site of the Proposed Development are shown in Figure 7.12. There is general agreement across the range of projections that mean, mean maximum and hottest day of the year temperatures will rise throughout the century. The central estimate projection is for an increase in seasonality of rainfall, with significant increases in winter and decreases in summer. There is projected to be an increase in the intensity of extreme rainfall events. Whilst not identified in the core outputs from UKCP09, there is also a high likelihood that drought events will become more severe.

11 UKCP09 is the most up-to-date set of climate change projections for the UK at the time of writing this report. UKCP18 is due for release in November 2018.

		2030s		2050s		2080s	
		Trend	Central Estimate	Trend	Central Estimate	Trend	Central Estimate
TEMPERATURE	Mean annual	↑	+ 1.82°C	↑	+ 2.78°C	↑	+ 4.39°C
	Mean summer	↑	+ 2.04°C	↑	+ 3.16°C	↑	+ 5.1°C
	Mean winter	↑	+ 1.52°C	↑	+ 2.31°C	↑	+ 3.41°C
	Mean maximum summer	↑	+ 2.69°C	↑	+ 4.15°C	↑	+ 6.6°C
	Mean minimum winter	↑	+ 1.81°C	↑	+ 2.72°C	↑	+ 4.1°C
	Hottest day	↑	+ 2.62°C	↑	+ 3.63°C	↑	+ 5°C
	Coldest night	↑	+ 1.73°C	↑	+ 2.32°C	↑	+ 2.79°C
PRECIPITATION	Mean annual precipitation	↕	+ 0.16%	↕	- 0.04%	↕	+ 0.79%
	Mean summer precipitation	↓	- 10.85%	↓	- 19.63%	↓	- 29.38%
	Mean winter precipitation	↑	+ 9.15%	↑	+ 17.16%	↑	+ 27.51%
	Precipitation on wettest day summer	↕	- 2.98%	↓	- 6.36%	↓	- 13.73%
	Precipitation on wettest day winter	↑	+ 5.37%	↑	+ 13.20%	↑	+ 22.82%

Fig. 7.12 Climate Change Projections

The impacts of climate change are considered within the design of the Proposed Development:

- Within the drainage design for new or modified components, as per the climate change allowances specified in the National Planning Practice Guidance[12]. More details are provided in Environmental Statement Chapter 12: Surface Water and Flood Risk and Chapter 13: Groundwater;
- Within the design of ecological mitigation measures, through the planting of climate resilient species and increased connectivity of habitats. More details are provided in **Environmental Statement Chapter 11: Biodiversity**;
- Demand for water is reduced through water efficiency measures such as efficient appliances/processes and the use of rainwater recycling, as described in **Section 7.7** of this DAS. This increased the resilience of the Proposed Development, and Bristol Airport as a whole, to increased pressures on Deployable Output evidenced by Bristol Water in their most recent draft Water Resources Management Plan[13];
- **Section 7.6** of this DAS sets out the viable options for onsite renewable energy generation. Decentralised power production reduces exposure of Bristol Airport to wider power failure, which can be exacerbated by climate change. Solar PV will make

12 Environment Agency (2017). Guidance. Flood risk assessments: climate change allowances. [online'. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances [Checked 15/10/2018].

13 Bristol Water (2018). Draft Water Resources Management Plan 2019, [online]. Available at: http://www.bristolwater.co.uk/about-us/environment/water-resources-plan-2019-update/ [Checked 15/10/2018].

up most of the on-site generation, although there is scope for small/medium-scale wind turbines and solar thermal generation as well. There is a commitment that decentralised renewable electricity generation will constitute a combined 15% of electricity use across Bristol Airport. Heating sourced from waste gas from a CHP plant also decreases reliance on the wider network, thus increasing resilience;

- The projected central estimate temperature projections for the end of the design life of each asset will be considered in its detailed design stages (e.g. a building with an indicative 50-year design life will consider climate change projections for the 2080s). The extent to which temperature thresholds in design standards for each asset are compliant with the climate change projections (see Fig. 7.12) will be considered. In some cases, the decision taken may be to adapt in the future rather than in the initial design. Where this is a viable option, the infrastructure will be designed in such a way to make this possible (e.g. oversizing of ventilation). Other adaptation may occur in the maintenance and replacement cycle (e.g. for short-lived assets where considered more distant climate change projections is not relevant);

- There is no usable information on changes to extreme windspeeds and storminess in UKCP09, although there is evidence that storms will become more severe in the future. The exacerbation of extreme weather events is also considered in operational resilience planning. Whilst overall winter temperatures are increased, the potential for extreme cold events remains and so operational readiness will be maintained; and

- The effects of severe weather over the construction period are considered in the CEMP and Bristol Airport will introduce a climate change and carbon action plan which will include measures involving adaptation. This will be developed under any future Section 106 agreement.

APPENDIX A: SERVICES INFRASTRUCTURE

Bristol Airport

A.1 Load Estimates

Preliminary site-wide area based loads have been estimated for each of the utility services, in order to assess whether the existing infrastructure is capable of coping with increased demand resulting from increased passenger numbers as a result of the development, or whether reinforcement of the infrastructure may be required. This issue is only of relevance to the planning application should any significant increase in facilities be necessitated, particularly if these are off site, and could be deemed to have an environmental impact. These load estimates are based on existing demands, increased pro-rata for the scale of the planned development, and consider the developments contained in the planning application with appropriate allowances for possible future development. Energy targets have been stated earlier in this section, and energy saving measures using the latest available technology will be applied to the design to reduce energy requirements and ensure compliance with the stated targets. The estimates shown below are deliberately conservative and are for the purposes of assessing the existing infrastructure capacity only.

A.2 Electricity

A.2.1 Summary

Bristol Airport is served from a Western Power Distribution Ltd (WPD) primary sub-station adjacent to the A38 which provides High Voltage (HV) power to a central HV switchboard. From this switchboard, two HV rings are provided to serve the airport. The original HV ring is routed around the whole airport site; a second ring has been added that is routed on the northside of the airport only. In general terms, the original site-wide ring main supports the airport developments that occurred prior to 2000, and the new ring main supports the developments post 2000 i.e. the new terminal building, the control tower etc. The Proposed Development plans to 2021 (10 mppa) will result in an increase in the site-wide electrical load. It is anticipated that this can be met by the existing WPD primary sub-station.

At 2021 (10 mppa), both of the HV ring systems can support the estimated additional load, however additional sub-stations and onsite infrastructure works i.e. diversions, sub-station relocations, etc. will be required.

A.2.2 Load Estimates

Electrical maximum demands (MDs) 12 mppa have been estimated and are summarised below;

	Load (MW)
Current measured (MD) 2018	2.900
MD 10 mppa Increase	1.300
MD 12 mppa Increase	1.600
Target 12 mppa MD Total	**5.800**

Fig. A.2.2 – WPD Electrical Maximum Demand from Actual Data

A.3 Communications

A.3.1 Existing Site-wide

The site is served from the A38. The IT cabling (e.g. BT) is ducted to the various buildings both on the north and southsides of the airport. These services included both copper and fibre connections. The major communications hub for the airport site is located in the basement of the existing terminal with smaller communication connections to other isolated buildings.

A.3.2 Future Works

A new administration building is currently under construction on the southside of the runway and is due for completion in the summer of 2019. The IT infrastructure and incoming communications is undergoing a rationalisation as part of this contract with new fibre and copper networks being installed within the boundary of Bristol Airport. These works are the platform for any possible growth.

A.4 Mains Cold Water

A.4.1 Existing Supplies

The airport has two Bristol Water cold water mains supplies – one to the northside and one to the southside. The mains serve the buildings, the site fire hydrants and a number of external irrigation points. The Bristol Water meters are installed at the site boundary. The onsite sections of the water mains are private. The southside Bristol Water main was upgraded to 100mm ∅ as part of the WPD Hangar project works, the on-site pipework was also increased to 100mm ∅. The northside supply is taken from the 250mm ∅ Bristol Water main running along the A38, the on-site main pipework is 180 mm ∅ MDPE.

A.4.2 Peak Supply Capacity

In the planning period there is not expected to be any issues in terms of storage capacity. However, when there is a full understanding of the water demand as a result of new developments in the planning period, the retailer (Water2Business) has recommended reviewing the size of the main flowmeter. Bristol Airport's local water company has spent the AMP6 investment period (2015-2020) developing resilience in the network to ensure that all areas of their network can supplied from both the North (Sharpness Canal) and South (Mendip sources). BRS is one of their key customers in terms of maintaining a reliable supply.

A.4.3 Peak Flow Requirements

As of October 2018, Bristol Airport's average daily demand is 300m^3 and average hourly demand is 12.5m^3. Demand has increased year-on-year, albeit 2018 has a similar summer peak profile to 2017. In the period in the table overleaf, there has been two terminal extensions; East Terminal Extension and the West Terminal Extension. The two months highlighted in red represent months where there has been a significant water leak so meter records have been reset. Water demand follows the seasonality profile of a summer peak. Based on anticipated developments, particularly in the terminal, further year-on-year growth in demand seems reasonable unless new technology is incorporated and/or developed to further water usage efficiency.

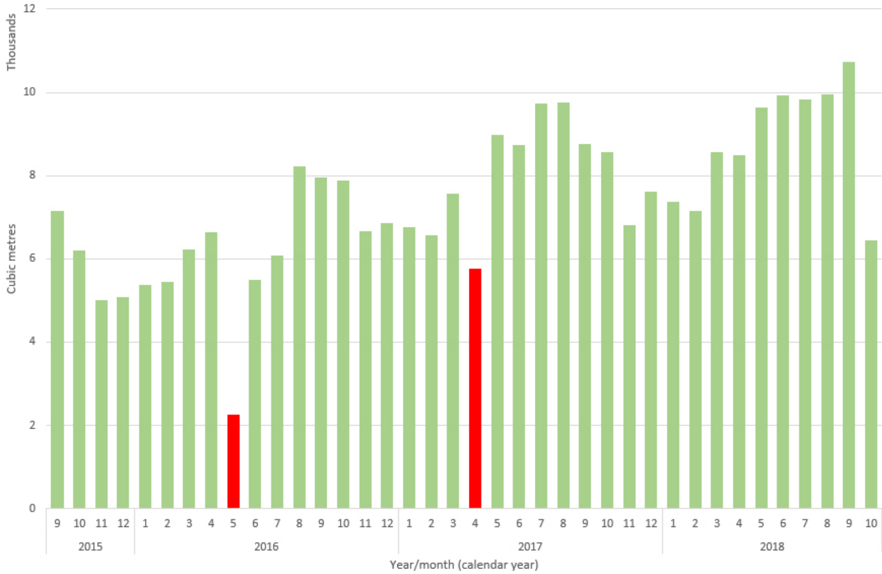

Fig. A.4.3.1 Peak Flow Requirements – BRS Water Demand and associated Developments

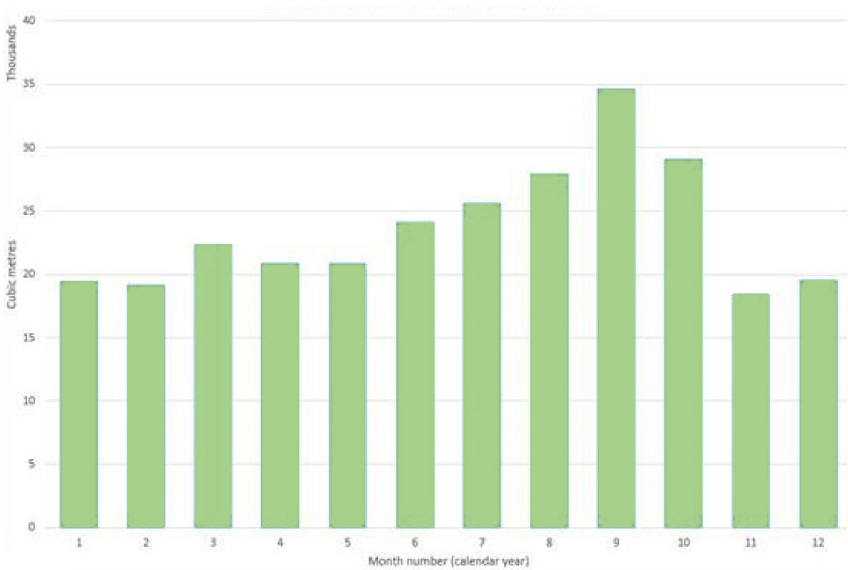

Fig. A.4.3.2 Peak Flow Requirements – BRS Water Demand Seasonality

A.4.4 Possible Works

Airside projects: There is a significant amount of airside development in the 10-12 mppa period, but water demand as a result of these developments is expected to be minimal. Concrete batching for apron and taxiway development will take place off site. Additional based aircraft will be utilising the new aircraft stands and will therefore consume water for the aircraft services when in use. The remainder of the developments are reconstruction and taxiway-based.

Terminal projects: There are a number of projects in the period that are likely to impact on water demand. A South Terminal Extension is planned for the early 2020's, which will house additional food and beverage units. Around the same time, a pier including additional coaching gates will start to develop along the eastern apron. A small West Terminal Extension is planned for 2021, and a larger West Terminal Extension begins toward the 12 mppa threshold. Historical requirements show us that water demand rises with the introduction of terminal extensions, so we should bear this in mind for the planning period.

Car park projects: The main focus in the planning period is development of further multi-storey car parking capacity. The first multi-storey car park was constructed with steel and pre-cast concrete, with low water demand. The second multi-storey car park construction has not yet been confirmed, and we would need to look at any potential impact on water demand if the project is approved.

Other projects: Construction of a new administration building and fire station is currently in progress. These are being constructed with water-saving taps and similar devices.

Discussion with Bristol Airport's clean water retailer suggests that the current capacity is suitable in terms of storage and incoming network for the period up to the mid-2020's. They have suggested considering upgrading the main flow-meter when there is a better understanding of the impact of the projects listed above.

A.5 Natural Gas

A.5.1 Existing Gas Main

The northside of the airport is served by a medium pressure natural gas main, there is no gas supply to the southside. The on-site section of the gas main was designed and installed by GTC, who have provided the following information:

- The on-site main is 250mm ∅ at the inlet. The majority of the on-site pipework is 180mm ∅ which terminates at Gate Gourmet. The terminal and Gate Gourmet have 125mm ∅ supplies. The original main has been extended to serve the Control Tower;
- The off-site main operates at medium pressure (90mbar). There is a pressure reducing station at the site boundary that restricts the on-site main pressure to 45 mbar; and
- The main is now at full utilisation and would require re-enforcement to deliver additional duty.

A.5.2 Peak Load Requirements

Heating energy for the existing development is provided by a combination of gas, oil (fossil fuels) and electricity. Peak fossil fuel loads for the current development and for the Proposed Development up to 12 mppa have been estimated and are summarised below:

	Fossil Fuel Peak Load (kW)
Current [14]	4,200
10 mppa Increase	0.000
12 mppa Increase	1,500
Post 12 mppa Total	**5,700**

Fig. A.5.2 Fossil Fuel Peak Load Increases

This estimate shows that the total peak load for developments up to 12 mppa will exceed the original design load for the gas main. Thus, post 10 mppa BAL will be required to reinforce their gas main. However, the following mitigation should be considered;

- The equipment in the terminal building dating from the year 2000 will be replaced with new more efficient plant, thus when considered in this way a reduction in CO_2 per kWh would occur.
- The pumping systems would be upgraded and demand driven variable pumping systems introduced. This would demonstrate a reduction in CO_2 per kWh.
- By having central plant, redundancy from standalone plant rooms is reduced. This will decrease the peak gas load and increase efficiency.
- Demolition of old facilities will reduce load.

A.6 Foul Water Drainage

A.6.1 Existing Foul Water Drainage

The existing foul water drainage network for the airport is split between two catchments, one to the south of the runway and the other to the north.

The southern catchment is pumped north, and discharges into the northern systems near the north-east corner of the airport site at which point the flows are discharged, by gravity, to an existing public foul sewer in Downside Road at Wessex Water manhole reference ST 51650604. The public sewer is then routed out to the A38 and then flows via the villages of Felton, Winford ultimately discharging to the Wessex Water sewage treatment works (STW) at Chew Stoke, Wessex Water STW reference 13058.

14 The oil fired boiler plant in the old terminal building will be decommissioned in 2019. The oil boiler plant in Northside House will be decommissioned in 2018. These numbers are thus not in the 12 mppa number.

The Environment Agency currently lists the treatment works as being due for an upgrade in 2019 however, Wessex Water have confirmed that the works have now been assessed for investment in their next business plan period (2020-2025) with a low probability of development occurring. No major works are planned at this time. It has also been noted that approximately 60% of the biological load received at the STW is generated by the airport site.

As far as can be established, the foul and surface water drainage systems are separate and therefore rainfall events should not have any effect on flows within the foul systems.

Wessex Water have a current restriction of a maximum discharge rate from the airport site of 12 l/s and, under the previous 10 mppa application, it was established that a storage tank was to be provided in order that peak flows exceeding this value could be retained for discharge at off-peak times.

A.6.2 Impact of this Application

The application proposals which will impact on the foul drainage system are as follows;

- Western extension to main terminal building;
- Southern extension to terminal building;
- Removal of existing administration block; and
- Removal of ‘Gate Gourmet’ building.

The remainder of the application proposals will not have any foul drainage implications.

A.6.3 Future Peak Foul Flows

Future flows will be generated by the terminal building extension works only. The peak month for passenger numbers is August and previous analysis carried out for the 10 mppa application has established that this is approximately 11% of the yearly capacity. At the same time, the existing Administration Block and Gourmet Gateway building will be removed and this will offset to a limited degree the increase in flows from the expansion works. Taking into account other existing flows from facilities that ae being retained, the peak foul flow rate for the 12 mppa application will be 39.3 l/s.

Detailed calculations are included in Section 4 of the Foul and Surface Water Drainage Strategy report.

A.6.4 Future Peak Foul Flow Volumes

As noted in section A.6.1 above, the final discharge rate from the airport site to the exiting public foul sewer is restricted to 12 l/s by Wessex Water. Currently foul flow rates are attenuated by the provision of a storage tank in the north-east corner of the site. This feature will require to be upgraded in order to deal with the increase in overall flows generated by the expansion works.

Detailed calculations are included in Section 4 of the Foul and Surface Water Drainage Strategy.

A.6.5 Proposed Foul Water Drainage

Where possible, existing foul drainage systems will be maintained. New connections and drainage runs will be constructed to serve the terminal building extensions. It will also be necessary to divert existing foul drains in certain locations in order to permit the construction of new buildings.

A.6.6 Foul Water Drainage Strategy

All foul drainage from the site drains via both gravity and pumped systems to the north-east corner of the airport site at which point flows are discharged to a public foul sewer in Downside Road.

Wessex Water currently restrict the maximum flow rate from the airport site to 12 l/s. This rate is restricted by the capacity of the Chew Magna sewage treatment works. Wessex Water have confirmed that there is no short-term intention to upgrade these works at present.

The increase of the airport capacity to 12 million passengers per annum will give rise to an increase in foul flows. Given that Wessex Water have no intention to carry out works to the sewage treatment works to increase capacity, then the current 12 l/s restriction will remain in place. In order to cater for the increased flows, it will be necessary to extend the existing on-site storage tanks.

The provision of additional storage and maintaining the current discharge ate from the site will ensure that there is no detrimental impact on the off-site public sewer network.

A.7 Surface Water Drainage

A.7.1 Existing Surface Water Drainage

The site is served by an entirely private drainage systems which is owned and maintained by Bristol Airport.

Currently, surface water runoff from both 'landside' and 'airside' features is collected via a series of gulleys, drainage channels and roof drainage systems into a positive piped network. Ultimately, all runoff discharges to soakaway features located throughout the site and are variously of either perforated ring construction, tanks or filter trenches. Where appropriate, water is passed through petrol/oil interceptors before discharging to the soakaways.

The drainage system has been added to, amended, or abandoned over time as various parts of the site have been redeveloped. Not all of these works have been recorded and therefore there is no definitive, overall record plan of the current drainage network. It should also be borne in mind that there is a more or less continuous Phase of improvement works being carried out which affect and alter the drainage network.

A more detailed description and assessment of the existing drainage for each of the specific application areas is set out in the relevant sections below.

A.7.2 Proposed Surface Water Drainage

Following on from previous work on the airport site, the strategy will be to infiltrate all surface water runoff from the proposed application works to ground following the principles that have been established to date.

Due to the nature of the site, the provision of open water features such as ponds or swales is not encouraged in order to reduce the potential risk from bird strikes. For this reason, these types of SuDS features are not included in the proposals and water quality will be addressed through the provision of filtration devices and oil interceptors, as appropriate.

Infiltration testing has previously been undertaken across the site as part of previous planning applications and detailed designs. Across the northern section of the airport site an average infiltration value of 4.2 x 10-5 m/s was found for the area in the vicinity of the Set Down/Pick Up Car park and Hotel area and an average value of 5.13 x 10-5 m/s was established across the surface car parks. Previous infiltration testing has been undertaken for the 'Cogloop 1' parking area to the south of the runway established an average infiltration rate of 3.35 x 10-5 m/s. This value has been used for the initial assessment of the proposed Cogloop 2 parking extension.

Additional site testing will be carried out at the specific soakaway locations prior to construction and the design details amended as necessary.

All soakaways will be designed to cater, as a minimum, for the 1 in 30 year storm event and will be tested for the 1 in 100 year event plus an allowance of +40% for climate change in order to assess the performance of the structure. All soakaway structures shall be located a minimum of 5 metres from any building.

A detailed assessment of each application element is set out in the accompanying Drainage Strategy report.

A.7.3 Surface Water Drainage Strategy

All existing surface water from the airport site currently discharges to ground via numerous infiltration systems. There is no discharge to public sewers or watercourses.

The proposed redevelopment of various elements of the airport infrastructure will alter existing systems and introduce additional areas of surface water runoff.

The proposed drainage strategy continues and extends the use of infiltration systems to serve the proposed works. As for the baseline condition, no surface water will be discharged off site.

All infiltration systems have been designed for the 1 in 30 year return period event and tested for the 100 year event plus an allowance for climate change. Under no circumstances will flooding be permitted to occur for the 1 in 30 year event and, where the drainage system has been shown to flood, the volume of water has been determined and the location and depth identified.

The off-site risk from surface water flooding following the implementation of the Proposed Development will therefore not be increased.

APPENDIX B: BUILDING SERVICES STRATEGY

Bristol Airport

B.1 Overview

This section provides a summary statement of the preliminary proposals for the building services for 10 and 12 mppa developments. The servicing strategies to the smaller support buildings will be developed at the next stage.

The current proposals are based upon conventional servicing strategies. This is subject to development once the sustainable and renewable energy proposals have been agreed.

The design team has developed the proposals to ensure that the strategies adopted safeguard the future development of the airport wherever possible.

B.1.1 Design Standards and Criteria

The mechanical and electrical engineering services will be designed and installed in accordance with CIBSE / IEE recommendations, British and EN Standards and current good practice.

All external luminaires and lighting designs will meet the limitation of light pollution and the dark skies requirements.

B.2 Electrical Services

B.2.1 Electrical Supply

As part of BAL's policy of introducing sustainable technology to the airport, air source, absorption chilling, wind turbines, photovoltaic cells and combined heat and power plant will be considered\installed to supplement the existing mains electrical supply.

A wind turbine manufacturer of vertical axis wind turbines (VAWT) will survey the site and determine a suitable wind resource. These VAWT will be located on the top level of the multi storey car park.

B.2.2 Terminal Transformers

The existing terminal is currently served by two 3 MVA transformers (N+1) installed within a dedicated basement area on the southside of the West Terminal Extension building.

These transformers can support the full extensions at both the west 2, south and east ends of the building. This is based on energy saving load provision with in the terminal plus available capacity being utilised.

B.2.3 Communications

The existing terminal building systems will be extended and category 6 cables will be routed from the new and/or the existing Main and Sub Equipment Rooms to new outlets for FIDS, public and staff telephones, Check-in desks, ATMs etc.

The new southside administration building and the 2019 decommissioning of the old terminal building is currently driving an IT infrastructure project. The increase in communications demand and number of incoming lines are outlined below:

- New Admin building is a new FTTP service (96 fibres), 100 pair copper provision as well; and
- New Airline Building will have a new FTTP service and will utilise the existing Admin Building 100 pair copper.

B.2.4 External Lighting

External lighting to car parks, roads and the apron is dealt with in more detail in Section 6.0. Building mounted lighting will be modified, extended, relocated or replaced to suit the extension proposals. All external luminaires will be IP 65 rated.

B.2.5 Induction Loops

An induction loop for the hard of hearing will be provided at all new reception desks and specific points throughout the extension areas. The system will comprise a local loop and a loop amplifier.

B.3 Mechanical Services

B.3.1 Plant Requirements - Air Handling Units

New external air handling units (AHUs) will be required for the extension for the terminal building in both 10 and 12 mppa forms. Each AHU will include supply/extract decks, heat recovery and in some cases integral air/air heat pump sections. Space has been allocated at roof level for the additional plant.

B.3.2 Plant Requirements - Heating

For the 10 mppa buildings the existing gas fired boiler plant will provide all of the heating source and be supplement with heat pump technologies at the point of use. This may take the form of heat recovery VRF systems or reverse cycle heat pump air handling plant. In some case hot water will be generated by solar thermal and/or waste heat from the VRF cooling cycle.

For the 12 mppa development a new central boiler house facility with district heating mains is envisaged. This would include waste heat from a combined heat and power plant. A low grade district heating system with local heat pump boiler water/water booster stations would also be considered.

B.3.3 Plant Requirements - Cooling

New cooling plant will be required to meet the South Terminal Extension's additional mechanical ventilation load (AHUs) and internal building cooling loads. New high efficiency turbocor air-cooled chillers will supplement the existing turbocor plant. The new plant will provide chilled water-cooling to the extensions to the main terminal building and the associated air handling plant. Space for additional chiller is available alongside the existing plant and substation 13 has sufficient energy to power them.

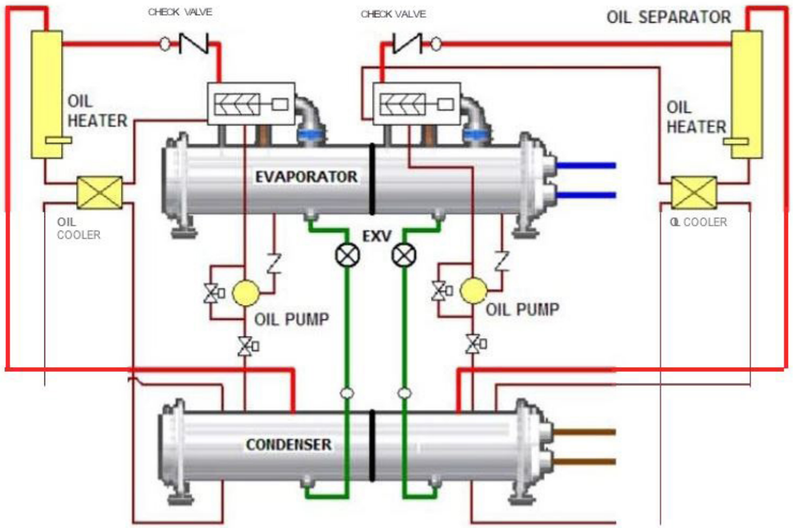

Fig. B.3.3.1 Typical Screw Water Cooled Chiller

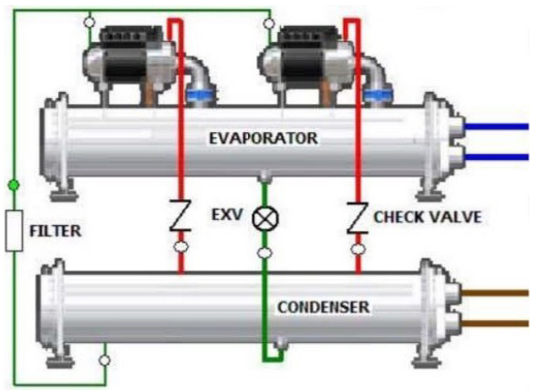

Fig. B.3.3.2 Turbocor Oil Free Water Cooled Chiller

B.3.4 Ventilation and Comfort Cooling Systems

The proposals for these systems are summarised below:

Public Areas	Due to the high occupancy levels of the public areas, an all-air system will be used. All-air systems also allow the significant benefit of 'free cooling' for a large proportion of the year with consequent energy savings. Due to the high variance of occupancy levels, the system should use variable air volume (VAV) control i.e. the air volume to the space is reduced as occupancy level reduces. This brings a further reduction in energy consumption, CO_2 emissions and operating costs.
Walkways	Mechanical ventilation will be provided to satisfy the minimum outside air requirements of the occupants by means of heat recovery outside air units. Cooling to be provided by means of heat recovery VRF Systems.
Offices	Minimum ducted fresh air supply and extract. Cooling to be provided by means of heat recovery VRF Systems.
Toilets	Supply and extract ventilation. Concealed ductwork and ceiling mounted grilles. Duplicate extract fans to be provided.
IT Rooms	Minimum ducted fresh air supply and extract. Cooling to be provided by means of fan coil units / close control units. Localised controls to avoid AHU's and chillers running at times of low passenger numbers.